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Automated Brain Tumor Detection and Brain MRI Classification Using Artificial Neural Network - A Review

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Abstract: ***Magnetic resonance imaging (MRI) is an important imaging technique used in the detection of brain tumor. Brain tumor is one of the most dangerous diseases occurring among the children and adults. It is apparent that of chances survival of patient could be expanded if tumor is identified at its initial stage. Manual classification of brain tumor is time devastating and bestows ambiguous results. Automatic image classification is emergent thriving research area in medical field. Brain MRI plays a very important role for radiologists to diagnose and treat brain tumor patients. In this paper we present an overview of the current research being carried out using the neural network techniques and Tissue Segmentation Techniques for the diagnosis of brain tumor. The goal of this study is to understand use of neural networks in classification of brain MRI image and use of tissue Segmentation techniques including Thresholding, Region Based Segmentation and Edge Based Segmentation in detection of tumor in brain MRI image.***

Keywords: MRI Brain Image, GLCM, FBNN, Support Vector Machine (SVM), Fuzzy C-Means.

1. Introduction

In recent years, the occurrence of brain tumors has been on the rise. Unfortunately, many of these tumors will be detected too late, after symptoms appear. It is much easier and safer to remove small tumors than a large one. About 60 percent of glioblastomas start out as a lower-grade tumor. But small tumours become big tumors. Low-grade gliomas become high-grade gliomas. Once symptoms appear, it is generally too late to treat the tumor, so there is need of an automated tumor detection system which will help in treatment of tumor. Computer-assisted surgical planning and advanced image-guided technology have become increasingly used in Neuro surgery [1].

Brain tumors may have different types of symptoms ranging from headache to stroke, so symptoms will vary depending on tumor location. Different location of tumor causes different functioning disorder [3].
The general symptoms of brain tumor are:
1) Persistent headache
2) Seizures
3) Nausea and vomiting
4) Eyesight, hearing and/or speech problems
5) Loss of sensation in arm.
6) Walking and/or balance difficulties.
7) Problems with cognition and concentration

Magnetic Resonance Imaging (MRI) is widely used in the scanning. The quality of image is high in the MRI. The quality of image is main important for detection of brain tumor. MRI provides an unparallel view inside the human body [6]. In MRI we can see detailed information exordinarly compared to any other scanning like X-ray, C.T scans. The contrast of tumor cell is high compared to normal brain cell. Brain MRI images with benign and malignant tumor are shown in fig.1.

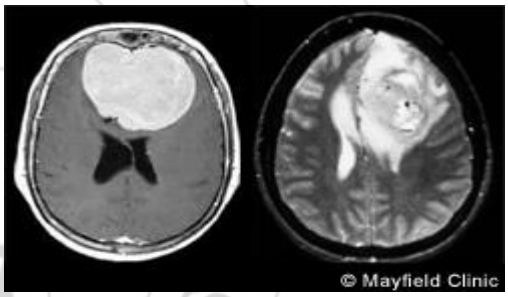

Figure 1: Brain MRI image with benign and malignant tumor

Treatment techniques for the brain tumor are as follows:
1) Surgery
2) Radio therapy
3) Chemotherapy

In the surgery process doctor remove as many as tumor cells from the brain. Radiotherapy is the common treatment used for brain tumors, the beta rays or gamma rays are passed into the brain and applied on the tumor and kill tumour cells. Chemotherapy is one of treatment for brain cancer [2], in this treatment medicine is used which controls the tumor cells to reach blood and blood barriers. In chemotherapy the medicine stops the growth of tumour cells and stops the growth normal brain cells. So, in chemotherapy treatment the patients face significant side effects.

2. Literature Review

Mubashir Ahmad, Mahmood ul-Hassan, Imran Shafi and Abdelrahman Osmantittle, there proposed work title was Classification of Tumors in Human Brain MRI using Wavelet and Support Vector Machine. In their work they carried feature extraction from MRI brain image using DAUB-4 Wavelet method. They used PCA to select the best

features for classification. These PCA selected features they were given as an input to SVM for classification. They were used two SVM kernel functions which were Linear Kernel and Radial Basis Kernel. Finally they found the high classification accuracy of 98.7% with Radial Basis Kernel[7].

SivaSankari.S, Sindhu.M , Sangeetha.R and ShenbagaRajan.A, worked on Feature Extraction of Brain Tumor Using MRI. They used median filter for removing the noise in an image in preprocessing stage. They extracted the optimal features of brain tumor by utilizing GLCM, Gabor feature extraction algorithm with the help of k-means Clustering Segmentation. They found efficient results[8].

Shweta Jain, Shubha Mishra, research title is ANN Approach Based on Back Propagation Network and Probabilistic Neural Network to Classify Brain Cancer. They presented an artificial neural network approach namely Back propagation network (BPNs) and probabilistic neural network (PNN) to classify the type of tumor in MRI images of different patients with Astrocytoma type of brain tumor. They used image processing techniques, histogram equalization, binarization, thresholding, morphological operation and region isolation for detection of the tumor in the MRI images and Gray Level Co-occurrence Matrix (GLCM) to achieve the texture feature extraction and those feature they used in the Training/Learning of the Artificial Neural Network. There complete system, worked in two modes firstly Training/Learning mode and secondly Testing/Recognition mode and efficiently classified the tumor types in brain MRI images[9].

Kailash D.Kharat , Pradyumna P. Kulkarni and M. B. Nagori did their work on Brain Tumor Classification Using Neural Network Based Methods. They worked with two Neural Network techniques for the classification of the magnetic resonance human brain images and the Neural Network technique consists three stages, namely, feature extraction, dimensionality reduction, and classification. In the first stage, they have obtained the features related with MRI images using discrete wavelet transformation (DWT). In the second stage, the features of magnetic resonance images (MRI) have reduced using principles component analysis (PCA) to the more essential features. In the classification stage, two classifiers based on supervised machine learning have developed. The first classifier based on feed forward artificial neural network (FF-ANN) and the second classifier based on Back-Propagation Neural Network. The classifiers have used to classify subjects as normal or abnormal MRI brain images. Finally they found effective classification results[10].

D. Selvaraj and R. Dhanasekaran discussed on tissue segmentation and feature extraction of MRI brain images, in their work they have reviewed and discussed types of features, including Shaped Based Features, Intensity Based Features, Texture Based Features and also MRI Brain Image Segmentation and Classification Methods namely Thresholding, Region Based Segmentation, Edge Based Segmentation, Classifiers (Supervised Method), Hybrid, Artificial Neural Network, Clustering (Unsupervised Method). Finally they concluded that BPN classifier gives fast and accurate classification that can be effectively used for segmenting MRI brain images with high level of accuracy[11].

Pankaj Sapra, Rupinderpal Singh, Shivani Khurana worked on Brain Tumor Detection Using Neural Network they proposed two approaches for Brain tumor detection, identification and classification. The first approach is based on an integrated set of image processing algorithms, while the other is based on a modified and improved probabilistic artificial neural networks structure. The proposed integrated image processing algorithm is based on a modified canny edge detection algorithm and implemented using MATLAB. However, simulation results using this algorithm showed its ability to accurately detect and identify the contour of the tumor, its computational time and accuracy were much less than its corresponding algorithms that use the parallel distributed processing nature of neural networks to reduce computing time and enhance the classification accuracy. This leaded them to propose a modified and improved probabilistic artificial neural networks structure. The modification is based on automatic utilization of specified regions of interest (ROIs) within the tumor area in the MRI images. From each ROI, set of extracted features include tumor shape and intensity characteristics are extracted and normalized. Each ROI is then given a weight to estimate the PDF of each brain tumor in the MR image. These weights are used as a modeling process to modify the conventional PNN. This method based on learning vector quantization (LVQ) which is a supervised competitive learning technique. This model is successfully tested by using a set of infected brain MRI-scan images to classify brain tumor. They used a database of 64 MRI-scan Gray-scale images; each image size is 220×220 pixels. Out of the 64 subjects a group of 18 random patients MRI images they were selected as a test set, while the rest of the dataset was used for training. Training data was used to feed into the neural networks as inputs and then knowing the output, the weights of the hidden nodes were calculated. Many trials were performed on the same Neural Network, selecting 18 subjects randomly every time for testing and the remaining subjects for retraining to find accuracy of neural network prediction. Simulation results showed that the proposed system outperform the presented system and successfully handle the process of MRI image classification with 100% accuracy when the spread value is equal to 1[12].

S.N. Deepa and B.A. Devi, their research tittle was Artificial neural networks design for classification of brain tumor. They exploit the capability of BPN and RBFN to classify brain MRI. Their proposed system consists of multiple phases. 42 patient's data sets were used. In preprocessing and segmentation, noise is removed and it involves sequence of steps to image classification. They were histogram equalization, region isolation and feature extraction. In Second phase brain images were classified on the basis of those texture feature using BPN and RBFN classifiers. After classification tumor region was extracted from those images. Finally they found that RBFN performs better with high convergence [13].

Kamal Kant Hiran and Ruchi Doshiworked on an Artificial Neural Network Approach for Brain Tumor Detection Using Digital Image Segmentation. They proposed an efficient algorithm for brain tumor detection based on digital image segmentation. An Artificial Neural Network Approach used for Brain Tumor Detection, which gave the edge pattern and segment of brain and brain tumor itself. They detected a Brain tumor through the steps image acquisition, preprocessing, image enhancement, thresholding, morphological operation. These algorithms they have developed on MATLAB version 7.6.0 platform[14].

Shweta Jain worked on Brain Cancer Classification Using GLCM Based Feature Extraction in Artificial Neural Network. Her proposed system classifies the type of tumor using Artificial Neural Network (ANN) in MRI images of different patients with Astrocytoma type of brain tumor. She has taken MRI database including Astrocytoma type of brain cancer and classified them into four types namely pilocytic (grade1), low grade (grade2), anaplastic (grade3) and glioblastoma multiforme (grade4). She has extracted texture features in the detected tumor using Gray Level Co-occurrence Matrix (GLCM). Those features she has given as input to artificial neural network for classification purpose. And her proposed system efficiently classifies the type of tumor[15].

Kshitija V. Shingare, N. D. Pergad worked on an Efficient Brain Image Classification Using Probabilistic Neural Network and Tumor Detection Using Image Processing. They proposed an efficient algorithm for brain tumor detection & identification using image processing and classification did using Probabilistic Neural Network Techniques. These techniques use the MRI Scanned Images to detect the tumor in the brain. Probabilistic Neural Network with radial basis function used to implement an automatic Brain Tumor classification. Decision making was performed in two stages: feature extraction using GLCM and the classification using PNN network. The performance of this classifier was calculated in terms of training performance and classification accuracies. Their simulated results showed that classifier and segmentation algorithm provides better accuracy than previous methods[16].

Prof. V. Gupta, K. S. Sagale, research tittle implementation a classification system. This paper was an extension in computer aided diagnosis for early detection and prediction of brain cancer using texture features and neuro classification logic and back propagation neural network. This paper was an extension of their previous paper based on locating tumor extracting features from brain cancer affected MRI. They have considered Astrocytoma type of brain cancer in their study. In clustering the samples of 60 MRI, images were processed through histogram equalization, binarization, morphological operations feature extraction neuro-classifier and categorized into 4 classes. The distinct feature was extracted using GLCM. Then they used multilayer feed forward used with back propagation algorithm for classification the output of ANN was compared with the target vector to predict the class of tumor [17].

Rajesh C. Patil, Dr. A. S. Bhalchandra discussed on Brain Tumor Extraction from MRI Images Using MATLAB. They discussed the proposed strategy to detect & extraction of brain tumor from patient's MRI scan images of the brain. Their proposed method incorporates some noise removal functions including high pass filter, median filter, and segmentation including threshold segmentation, watershed segmentation and morphological operations which are the basic concepts of image processing[18].

Mandhir Kaur and Rinkesh Mittal researched an Efficient Scheme for Brain Tumor Detection of MRI Brain Images Using Euclidean Distance With FVT. In this research work, they have developed a simple approach for detection of brain tumor which is based on the method using Euclidean distance classifier and making use of feature vector table and which over comes the limitations of conventional in which combination of supervised and unsupervised learning have implemented to build cancer detection system. Their proposed method first convert the image into indexed image, then after de noising it with 3*3 mean filter, it conducts the block wise scanning to get feature set of statistical features in both frequency and time domain and finally based on Euclidean distance measures an optimized tumor part is segmented which is ROI (region of interest) then this segmented part is validated and test to arrive at exact brain tumor part required. They found result with high reduction of time, increased specificity with better accuracy in terms of true positive rates[19].

A.A. Badarnel, H. Nafadat and A. M. Alraziqi, tittle is A classifier to detect tumor disease in brain MRI brain images. In their work shows the effect of neural network and K-nearest neighbor algorithm for tumor and non-tumor MRI classification. In those proposed work the dataset consists of 710, T2 weighted and axial, 256*256 pixel MRI images. In feature extraction they obtained 275 brain MRI texture features, those features were passed to ANN and K-NN classifier. Finally they evaluated the performance of the proposed method in term of confusion matrix, sensitivity, specificity and accuracy. Finally they found 100% classification accuracy achieved by K-NN and 98.92% by neural network[20].

Biniya Kocharakal Binoy, Divya Shetty and Jose Alex Mathew discussed on A Comparative Study of Different Techniques used for Brain Tumor Classification. In this paper, a comparative study of three different techniques namely, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) each separately combined with the Probabilistic Neural Network (PNN is used for the classification of brain tumors. The system takes Magnetic Resonance Image (MRI) as input and classifies into benign or malignant tumors[21].

R. J. Deshmukh ,R. S. Khule worked on Brain Tumor Detection Using Artificial Neural Network Fuzzy Inference System (ANFIS). In their proposed methodology, they were extracted features from raw images which were then they fed to ANFIS (Artificial neural fuzzy inference system).ANFIS being neuro-fuzzy system harness power of both hence it proves to be a sophisticated framework for multiobject

classification. A comprehensive feature set and fuzzy rules were selected to classify an abnormal image to the corresponding tumor type. This proposed technique was fast in execution, efficient in classification and easy in implementation [22].

3. Conclusion

The brain tumor detection is a sensitive and complicated task; therefore, the accuracy and reliability takes much importance. Many brain MRI image segmentation methods and classifiers have been developed in the past several decades for segmenting MRI brain images and classifying it as normal or abnormal. The survey shows that Back propagation neural network classifier which can be used in classification of Brain MRI image gives fast and accurate classification results, when large number of nodes in its layers can be used. Also that can be effectively used for segmenting MRI brain images with high level of accuracy. Levenberg- Marquardt algorithm performs better than others. Also the survey shows that ANN classifier performs good classification of brain MRI image in the datasets with bigger amount of input features while SVM performs better with smaller amount of input features of those dataset. In future work using the other techniques such as double thresholding and morphological and GLRLM operations with neural network (FBNN) classification of MRI images can also be done.

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